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The Southwest Telehealth Access Grid

An Integrated Interstate Network of Networks Model for Telehealth

Principal Investigators:

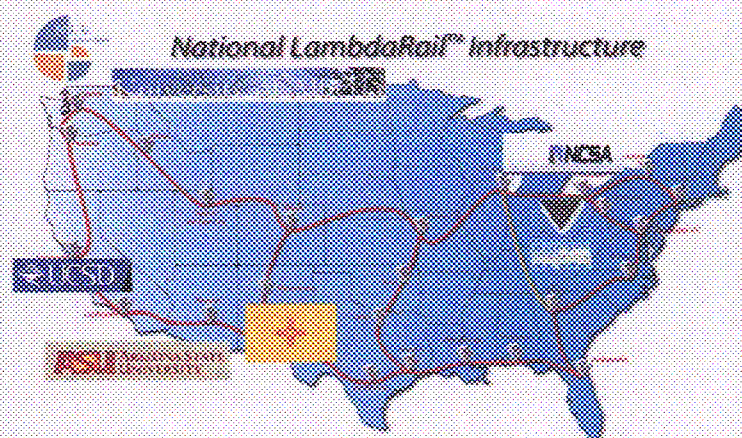
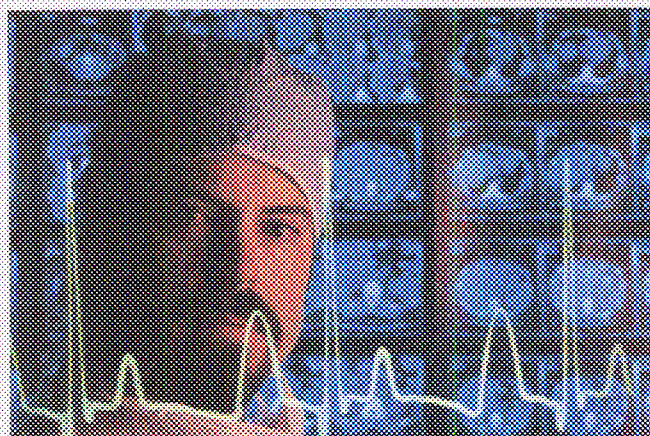
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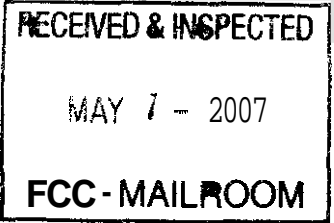
FCC Rural Health Care Pilot Program, Docket # 02-60





THE UNIVERSITY OF NEW MEXICO
HEALTH SCIENCES CENTER

HSC Controller's Office



May 4, 2007

TO WHOM IT MAY CONCERN:

Please accept this application entitled Southwest Telehealth Access Grid (TAG) on behalf of the University of New Mexico Health Sciences Center in response to WC Docket No. 02-60. Listed below is pertinent institutional information:

Institutional Legal Name: Regents of the University of New Mexico

DUNS #: 868853094

Federal Entity Identification Number: 85-6000-642

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We look forward to the opportunity to work with the Federal Communications Commission.

Thank you,

Rena Vinyard, Manager
PreAward Administration

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Southwest Telehealth Access Grid: An Integrated Interstate Network of Networks Model for Telehealth

Executive Summary

The Southwest Telehealth Access Grid (TAG) is an integrated interstate network of networks built upon the extensive experience of key participants in rural telemedicine and rural healthcare in New Mexico, Arizona and the Southwest Indian Health Service (IHS) Telehealth Consortium and associated Tribes. This Grid creates the platform to more effectively share, distribute and coordinate telemedicine clinical services, educational and training programs among the healthcare provider organizations across the region, along with their associated human resources, thus more easily and effectively filling the gaps in meeting the health care needs of the rural communities throughout the network. Through Internet2 (I2) and the National Lambda Rail (NLR), this regional TAG network of networks, which is greatly facilitated and enhanced by the current USF Rural Healthcare program and the newly announced FCC Rural Healthcare Pilot Program, will enable our participating hospitals, clinics, and educational institutions to partner with peers throughout the United States to improve healthcare delivery and education via telemedicine.

We propose to extend and leverage existing and planned statewide networking infrastructure initiatives and investments to create this telehealth access grid of rural healthcare telemedicine systems and integrate the high-speed Internet backbones offered by I2 and NLR with appropriate security and quality of service. This regional network infrastructure, augmented by regional and municipal hubs, also serves as the basis for our strategic plan for efficiently and cost effectively aggregating the specific needs of health care providers.

The TAG will significantly enhance our capacity to deliver critical rural healthcare services throughout the region. It is anticipated that 200 additional rural community sites will be added as the Southwest TAG develops. The grid will not only better support day-to-day telemedicine transactions among the participating agencies, but also provide a system that can be quickly transitioned during emergencies to support telehealth and other high priority traffic in the event of a natural or man-made disaster. It is important to note that much of the backbone design and deployment of the proposed network is already in place. The existing infrastructure allows us to direct our efforts, with a high likelihood of success, to address the primary issues of rural network connectivity, reliability and appropriate redundancy.

This proposal expands the ongoing work of the primary regional Telehealth alliances. These alliances have been fundamental to planning, implementing and coordinating a unified Telehealth network in New Mexico and Arizona.

Unique aspects and specific aims of this telehealth access grid are the following:

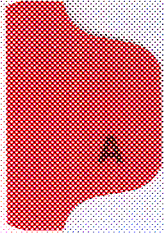
- 1) Develop an interstate regional network of networks telemedicine grid in Arizona and New Mexico that includes Indian Health Service (IHS) and Tribal facilities in the Navajo, Albuquerque, Phoenix and Tucson Areas of the IHS and associated Tribal communities
- 2) Extend and integrate existing statewide networking initiatives and investments including I2 and NLR in New Mexico and Arizona
- 3) Create a platform to more effectively share, distribute and coordinate telemedicine clinical services, and educational and training programs, among the healthcare provider organizations across the region, thus more easily and efficiently fill the gaps in meeting the healthcare needs of the rural communities throughout the network
- 4) Perform network design studies and modeling that insure the best investment in the enhanced telemedicine infrastructure and allow iterative improvements through ongoing simulation, testing, evaluation, development, and utilization
- 5) Incorporate security, improved reliability, quality of service, and appropriate redundancy that can support disaster recovery

The Telehealth Access Grid will integrate high-speed communication backbones with rural telemedicine networks enhancing capacity to support heavy data traffic and large files, as well as provide alternative pathways for data transfer. By connecting hundreds of communities, healthcare facilities, and their providers, TAG will support a broad spectrum of telehealth applications that serve rural communities and their citizens and address gaps in access to critical healthcare needs.

Designed as a phased two-year project, phase 1 will incorporate the network design studies, modeling and initial deployment to enhance the wide area networks and connections to I2 and NLR, which in turn will establish the basic infrastructure for the regional grid. Los Alamos National Laboratory, in conjunction with the University of New Mexico Department of Electrical and Computer Engineering, will advise and collaborate with the network design and deployment team to create a model of the network design. This model will be used to provide feedback to the network design group and to simulate the effects on the network from major disaster scenarios. Based on the ongoing evaluation, modeling and simulation, phase 2 will refine the TAG infrastructure, fill in gaps, and add more sites or networks as appropriate.

In conclusion, this TAG initiative is designed to serve as a model for developing a sustainable integrated nationwide telehealth network that supports and expands rural healthcare services while offering an immediate and efficient access grid in the event of a regional or national emergency.

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Proposal Checklist

- ☒ The organization that is legally and financially responsible for the conduct of activities. (Page 5 & 33)
- ☒ The goals and objectives of the proposed network. (Page 7)
- ☒ An estimate of network costs for each year. (Page 40)
- ☒ A description of how for-profit network participants will pay their fair share of the network costs. (There are no for-profit network participants.)
- ☒ The financial support source and anticipated revenues that will pay for costs not covered by the fund. (Page 40)
- ☒ A list of the healthcare facilities included in the network. (Page 5 & Appendix 1)
- ☒ The addresses and RUCA codes for each healthcare facility participating in the network. (Appendix 1)
- ☒ Previous experience developing and managing telemedicine programs. (Page 27)
- ☒ The project management plan outlining
 - Leadership (Page 5 & 33)
 - Management Structure (Page 33)
 - Work Plan (Page 33 & Appendix 1)
 - Schedule (Page 38 & Appendix 1)
 - Budget (Page 40)
- ☐ A description of how the telemedicine program will be coordinated through the state and region. (Page 27)
- ☒ How the network will be self-sustaining once established. (Page 53)

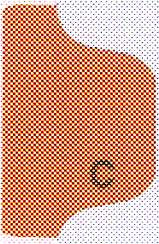
Lead Organization and Participants

Lead:

The University of New Mexico (UNM) Offices of the CIO and the UNM Health Sciences Center for Telehealth and Cybermedicine Research (CfTH & CMR) are the lead organizations for the Southwest Telehealth Access Grid (TAG).

Other Participants:

University of New Mexico (UNM)
 Center for Disaster Medicine (CDM)
 Carrie Tingley Hospital (CTH)
 Center for High Performance Computing (CHPC)
 Electrical & Computer Engineering (ECE)
New Mexico Institute of Mining and Technology (NMIMT)
New Mexico State University (NMSU)
State of New Mexico
 Department of Health (DOH)
Los Alamos National Laboratory (LANL)
Southwest Indian Health Service (IHS)
 Albuquerque Area IHS
 Navajo Area IHS
 Phoenix Area IHS
 Tucson Area IHS
Arizona Telemedicine Program (ATP)
Holy Cross Hospital (HCH) *private not for profit*
Presbyterian Medical Services (PMS) *private not for profit*
Sangre de Cristo Community Health Partnership (SDCCHP) *private not for profit*



The Telehealth Access Grid (TAG)

Telehealth is healthcare delivered, at a distance, using communications networks and information technologies. The concept is particularly applicable to rural communities, where access to healthcare services are often limited, affecting the health and welfare of the citizens, the community as a whole, and their economic viability and development.

New Mexico and Arizona, large rural states in the Southwest, represent many of the issues related to the potential benefits and challenges in developing a Telehealth System to serve its rural communities. Through our experiences, successes, failures and lessons learned, we have developed approaches to overcoming barriers to adoption and sustainability of Telehealth applications, including the establishment of partnerships with economic development projects in our state. Many of these hands-on experiences are applicable to other rural Telehealth programs and should be considered in strategic planning, implementation and maintenance, particularly during times of high demand and need for health services for the underserved within a complex, dynamically changing and challenging environment.

The major telecommunications stakeholders in this proposal will play a critical role in bridging serious healthcare gaps through the development of adequate, affordable broadband infrastructure to communities in their territory. This proposal leverages to a large extent existing statewide and regional network infrastructure and investments already in place. Most importantly, the Telehealth Access Grid (TAG) we propose creates the platform to more effectively share, distribute and coordinate telemedicine clinical services, educational and training programs among the healthcare provider organizations across the region, along with their associated human resources, thus more easily and effectively filling the gaps in meeting the health care needs of the rural communities throughout the network.

This model can be significant for the citizens of the communities it will serve. It will assist in the development of a sustainable network of networks that can support telehealth and other critical applications for education, government and business, thus addressing the necessary infrastructure required for enhanced economic development. As affordable broadband is put into place, consumers will have access to healthcare services in their home, workplace and local medical facilities. While this grid can operate in a normal standard mode to support many ongoing telehealth activities and transactions 24/7, it will also be available to immediately switch to emergency mode in the event of a natural disaster, critical public health issue, or terrorist event. Because of the unique challenges of our region, this successful Telehealth Access Grid will serve as a model for the rest of the nation and world.

TAG Goals and Objectives

The TAG goals are to:

1. Integrate existing high speed communication regional networks, such as I2 and NLR, to enhance rural health care telemedicine networks.
2. Leverage existing statewide and regional networking infrastructure initiatives and investments.
3. Create a platform to more effectively share, distribute and coordinate telemedicine clinical services, and educational and training programs, among the healthcare provider organizations across the region, thus more easily and efficiently fill the gaps in meeting the healthcare needs of the rural communities throughout the network;
4. Develop a reliable, secure, sustainable, Quality of Service (QoS) enabled telemedicine network of networks.
5. Provide a network that is available for emergency preparedness and disaster response in a timely, effective and efficient manner.
6. Provide a network that can support the rapid movement of large amounts of data and support effective interaction between participants within the network.

The TAG objectives are to:

1. Enhance provision of telemedicine services to rural communities.
2. Improve connectivity to rural sites receiving telemedicine services.
3. Significantly expand the number of connected sites in the region.
4. Make available appropriate redundancy for disaster recovery and QoS.
5. Provide the necessary support for high quality communication.
6. Offer a unique approach for the delivery of rural healthcare through the use of telemedicine.

In the page that follows is a matrix of all the TAG partners and their areas of expertise in Telemedicine and Networking.

FCC Rural Healthcare Pilot Program Participant Expertise

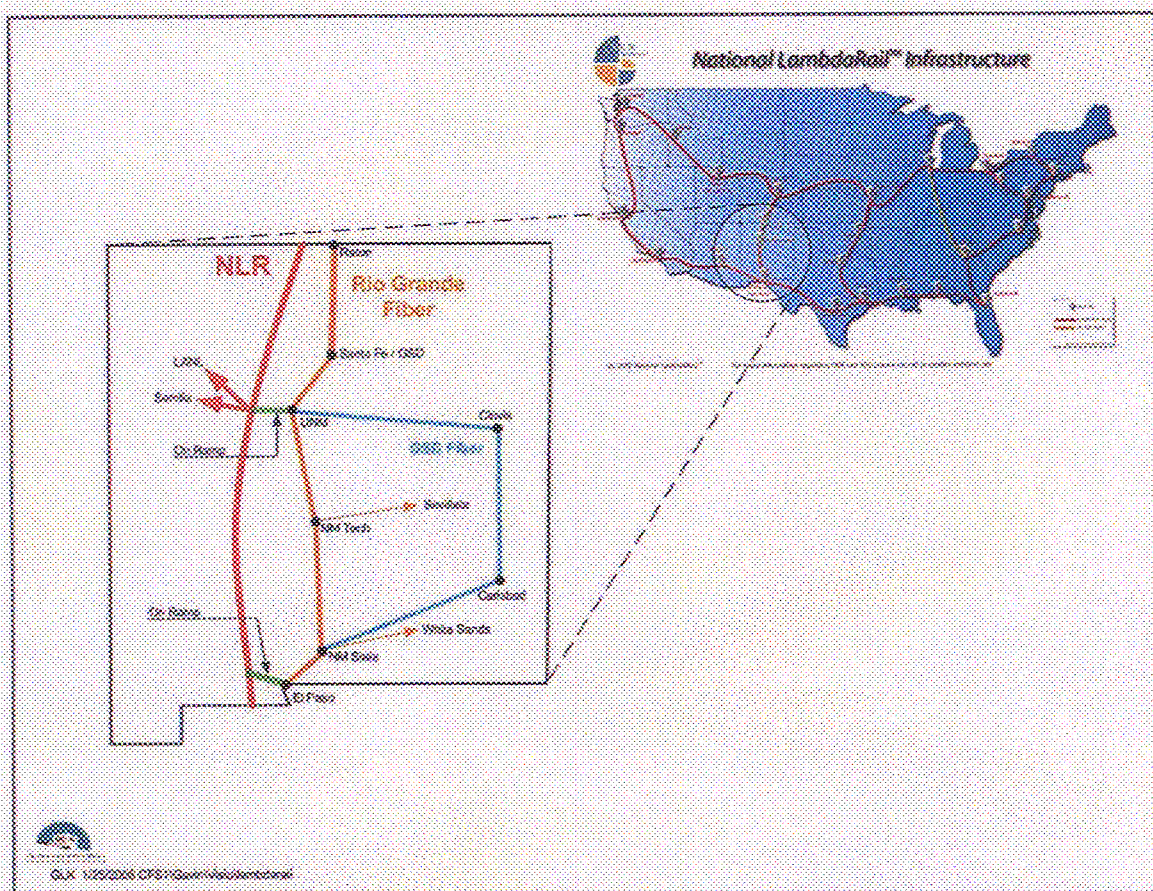
	Telemedicine Projects	Large IT Projects	Rural Health Services	Provide Telehealthcare	Multiple Technical Services to Rural America	Disaster Response	Designing Innovative Networks	Modeling Security	Modeling Large-scale Projects	High-speed Backbone Service	Diverse populations	Collaborative Projects	Diverse Stakeholders	Network Management & Monitoring
UNM														
Center for Telehealth	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Health Science Center Library and Informatics Center	x													
Center for Disaster Medicine	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Carrie Tingley Hospital	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Office of the CIO		x	x	x	x	x	x	x	x	x	x	x	x	x
Center for High Performance Computing		x	x	x	x	x	x	x	x	x	x	x	x	x
Electrical & Computer Engineering		x	x	x	x	x	x	x	x	x	x	x	x	x
New Mexico Institute of Mining and Technology		x	x	x	x	x	x	x	x	x	x	x	x	x
New Mexico State University		x	x	x	x	x	x	x	x	x	x	x	x	x
New Mexico Department of Health	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Los Alamos National Laboratory	x													
Indian Health Service														
Albuquerque Area IHS	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Navajo Area IHS	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Phoenix Area IHS	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tucson Area IHS	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Arizona Telemedicine Program	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Holy Cross Hospital	x	x	x	x	x	x	x	x	x	x	x	x	x	x
NM Telehealth Alliance	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Presbyterian Medical Services	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sangre de Cristo Community Health Partnership	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Networking Goals and Objectives

The infrastructure of a project this size requires the combined knowledge of experts in infrastructure technology. Participating infrastructure networking agencies and institutions in this proposal include the University of New Mexico (UNM), New Mexico Institute of Mining and Technology (NMIMT), New Mexico State University (NMSU), State of New Mexico Department of Health, UNM Electrical and Computer Engineering, and Los Alamos National Laboratories (LANL).

If funded, UNM, NMSU, and NMIMT will bring together an efficient, professionally managed core network of facilities that will maximize network performance and lower connection costs by using existing aggregation points of networks. Currently, NLR Points of Presence (POP) already exist in Raton, NM, Albuquerque, NM and El Paso, TX/Las Cruces, NM (joint New Mexico/Texas POP). Service levels for each POP are:

- El Paso/Las Cruces Services: 10-gigabit Ethernet, OC192 lambda, National Exchange Fabric, Dedicated FrameNet, Collocation Services, Cross Connections
- Albuquerque Services: 10-gigabit Ethernet, OC192 lambda, National Exchange Fabric, Dedicated FrameNet, Collocation Services, Cross Connection, Routable IP (planned).
- Raton Services: 10-gigabit Ethernet, OC192 lambda, Collocation Services, Cross Connection.



This core network of facilities and combined expertise will ensure an infrastructure that maximizes the number of connected areas and institutions throughout the southwest area in an efficient and cost-effective manner.

UNM, NMSU, and NMIMT will continue working on a formal design study in collaboration with the rural healthcare providers to build on and leverage existing statewide networking initiatives. The final design will be approved by all participating agencies. We will use the following criteria to guide the network design:

- Leverage existing networks and current infrastructure projects
- Minimize costs through volume purchases
- Identify network segments that can be provided by purchase of dark fiber or digital microwave instead of leased circuits
- Leverage existing NLR and I2 connectivity and provide redundancy through connections to NLR or I2
- Design an adaptable network that can easily support a wide array of telehealth applications
- Provide long term sustainability through initial capital investment with low recurring costs
- Greatly enhance bandwidth and throughput to accommodate any and all telehealth applications
- Create scalability and ease of adding new connections
- Leverage use of existing national operating centers (NOC) and management facilities to monitor and ensure QoS and reliability
- Maintain industry standard network reliability

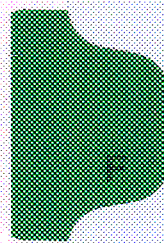
Ongoing goals are to expand existing optical network to the South East, North West and North central quadrants of the State of New Mexico to support Telehealth. The Major Universities are building a high capacity fully diverse and redundant fiber ring as its major backbone. This backbone network will have two interconnect locations with NLR and Internet2, one in Albuquerque, NM and one in El Paso Texas. Additional fiber initiatives will extend the high capacity backbone through the southeast, northeast and northwest regions of the State. The State-owned digital microwave network can easily be integrated to the fiber backbone to extend high bandwidth services throughout the state as part of phase 2 (year 2). The Major Universities are working with the local Telecom providers to establish peering sites to interconnect local services to the State own network. Through the partnership with the local providers and or the State owned network we will be able to extend into the rural areas to connect government agencies and rural telehealth sites.

If there is a disaster, because the network is owned by the State through the major Universities and not a public network, the critical traffic would be prioritized over non critical traffic so that there would not be any delays of information to emergency responders or medical facilities. The major backbone, being diverse and redundant, would continue to operate if there is a natural disaster that affected the network at any location along the fiber path.

While both UNM and NMSU maintain their own large telephone networks, the State of New Mexico operates the second largest phone system in the state. As history has shown during historic disasters such as 911 or hurricane Katrina, critical phone systems can be destroyed or rendered inoperable. Recently, the Virginia Tech shootings have shown that mass hysteria cripples

both voice and data networks. As part of phase 2, the TAG project puts New Mexico in a position to deploy a private, redundant telephone system that can alleviate problems that plague public systems during disasters.

It is the intent of the planned design study in year 1 to eliminate overlap in existing network designs described in this proposal in order to maximize performance and reduce the overall cost of implementation. The purpose of this study phase is to reduce the actual expenditure of capital requested in this proposal. Along with the above stated criteria, different modalities will be investigated such as Wireless Mesh Networks (WMN), microwave, free space optics, and others. Once the formal design is complete, existing work plans, schedules, and budgets will be revised, and implementation will begin.



Network Architecture Strategic Plan

The proposed network architecture is based on the following assumptions regarding the state's telecommunications infrastructure:

1. Costs will increase and availability will decrease with greater distance from the Rio Grande Corridor.
2. Local municipalities may have a greater range of connectivity options,
3. Dedicated long-haul, high bandwidth circuits are limited and costly.
4. Much of the long-haul infrastructure is being put into place by UNM, NMSU and NMIMT.

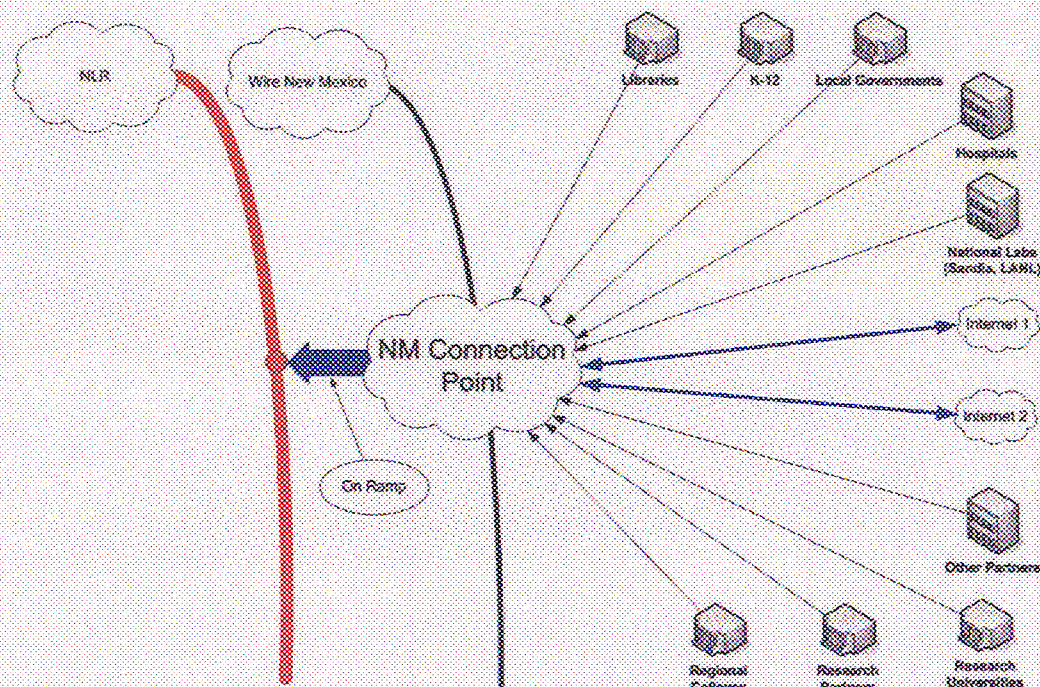
The strategic plan for efficiently and cost effectively aggregating the specific needs of health care providers is based on the following concepts:

Regional Optical Network. The partnerships between NMSU, NMIMT, and UNM on the Rio Grande Fiber Project and other networking projects (i.e., the Albuquerque Metro Area Fiber and the New Mexico Governor's Wire New Mexico initiative to create Regional Networks) will create a Regional Optical Network.

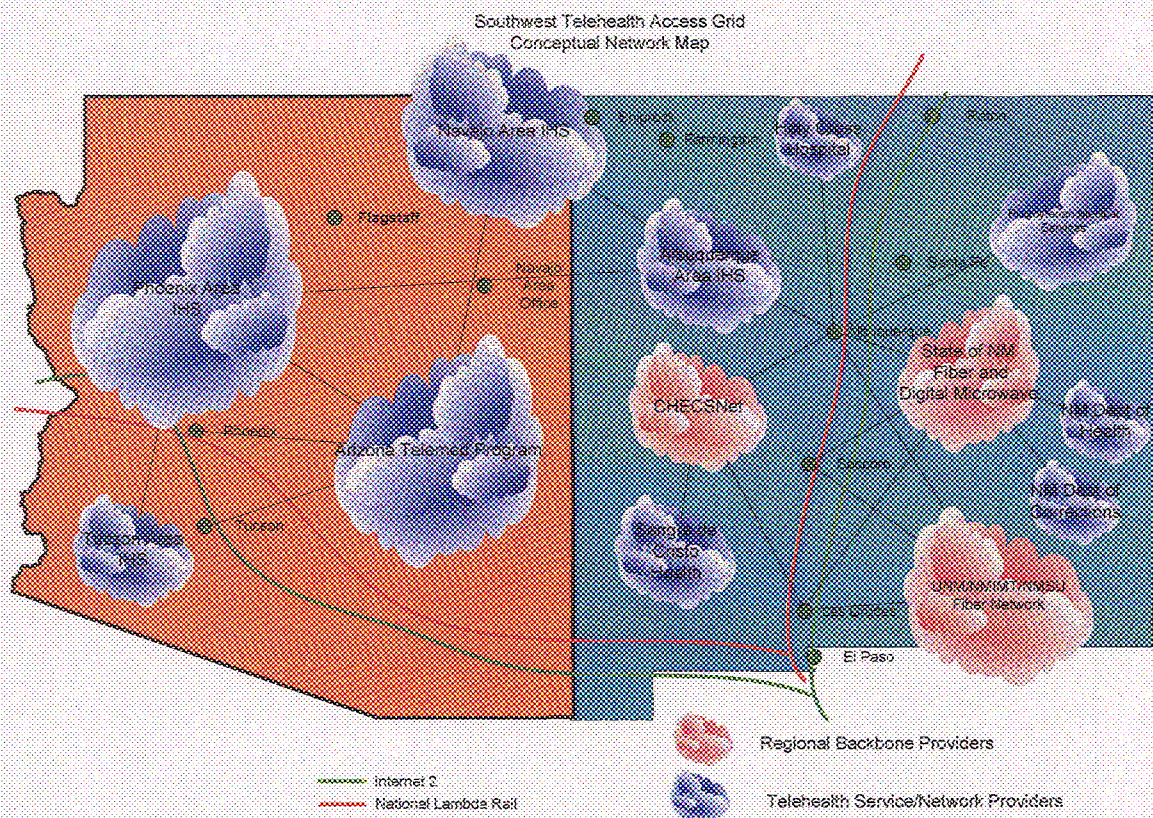
Regional Hubs are major institutional entity that serves as an aggregation point for regional network connectivity. A regional hub supports a high capacity connection to the state's network and would likely provide network connectivity to municipal hubs within the region. These regional hubs would be interconnected using a meshed or ringed topology and would serve two purposes: 1) reducing support requirements and 2) simplifying disaster recovery.

Municipal Hubs are an entity within a municipality that serves as a local aggregation point for area network connectivity. The municipal hub connects to a regional hub and allows municipal entities to take advantage of connectivity options that are locally available to connect to their local hub. This approach leverages vendor competition at the local level and allows for the creation of a municipal network for education or state government. The municipal hub may also serve as a regional hub in certain situations.

Collocation/Shared Application. Hubs may also serve as collocation sites, where appropriate, to reduce network congestion on limited bandwidth connections. By strategically locating application servers at hub sites, backbone traffic is reduced. This approach also lends itself to shared application hosting, further reducing support costs.



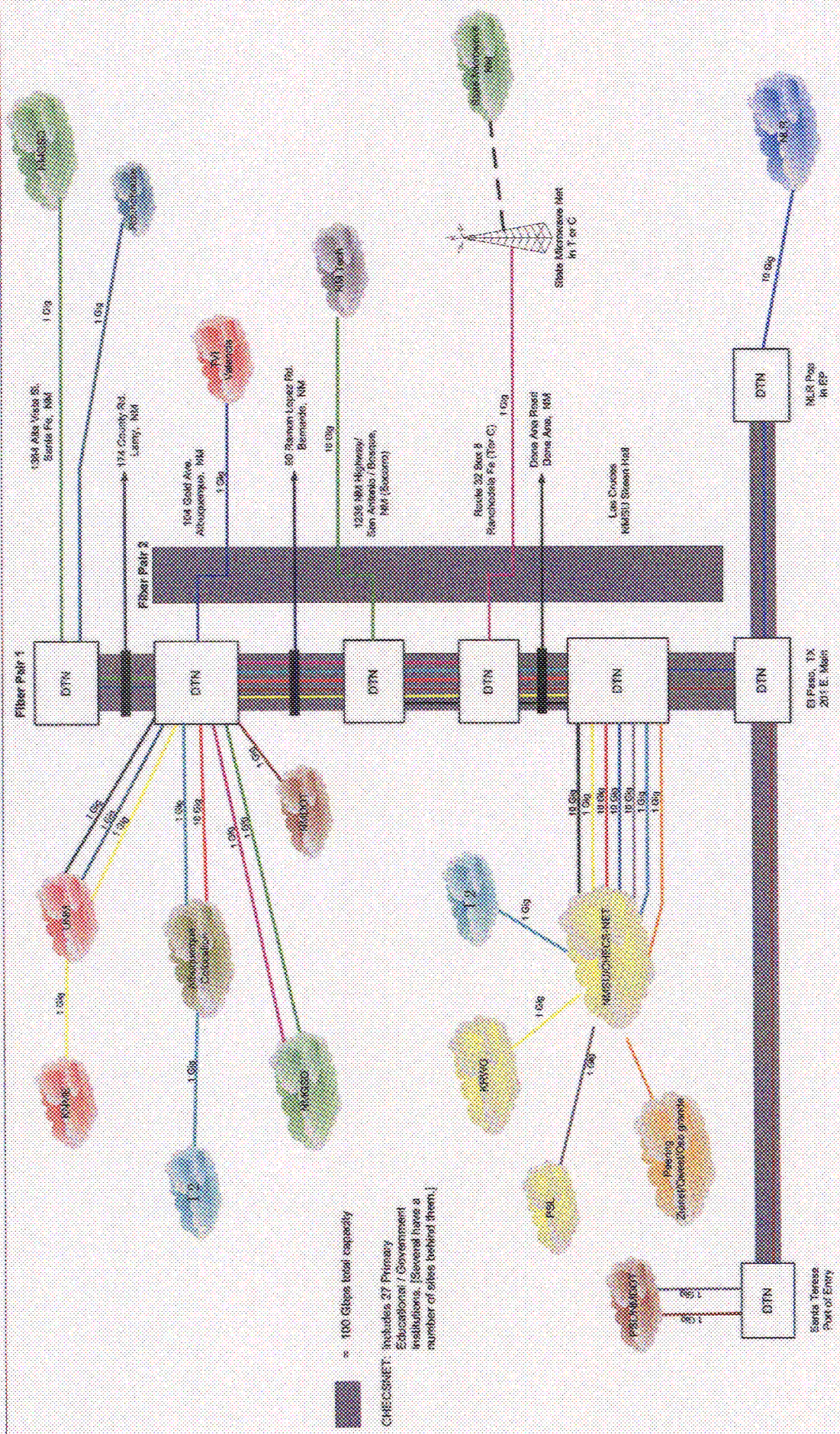
Connection of the regional networks will be done by regional hubs which would be an educational entity that serves as an aggregation point. A regional hub would support a high capacity connection to the state network and be responsible for providing network connectivity to municipal hubs in the region, allowing resources to be focused on supporting one major network pipe instead of multiple small pipes. The municipal hub would connect to a regional hub, allowing municipal entities to take advantage of connectivity options that are locally available to connect to their local hub. This approach leverages vendor competition at the local level and creates a municipal network of sites.



Backbone Network Architecture

New Mexico State University
Information and Communication Technologies
Telecommunication & Networking Services
880 Lambeth Blvd. DPHS Network Design

Revision Date: April 1, 2005
Submitted by: David Prosser



Experience Designing, Developing, and Managing High-speed Networks

University of New Mexico, New Mexico Institute of Mining and Technology (NMIMT) and New Mexico State University (NMSU)

The University of New Mexico (UNM), New Mexico Institute of Mining and Technology (NMIMT) and New Mexico State University (NMSU) oversee the operation of expansive and reliable campus, statewide and national networks that interconnect higher education, public education, government and national laboratories to commodity and research networks. These include a state fiber network, the Internet (I1), I2 and NLR. The network includes rural higher education campuses, agricultural experimental stations, Tribal networks, research parks and the Albuquerque and Las Cruces metro areas. Many telehealth services use these networks.

Existing statewide networking partnerships include CHECSNet, New Mexico Lambda Rail (NMLR), Sandoval County Broadband, General Services Division of NM State Government (GSD), Internet to the Hogan (ITTH) and the Rio Grande Optical Network. These networks are interconnected at aggregation points, or “GigaPops,” in the southern, central, and northern regions of New Mexico. Each POP is managed and maintained by professional network engineers 24/7. The depth and breadth of this operational responsibility has built up knowledge and expertise to support any proposed networking initiatives. The facilities use extensive electronic networking monitoring, including load balancing and intrusion detection, to oversee this “network of networks.” A minimal investment would be required to monitor the new rural telehealth sites.

UNM Electrical and Computer Engineering

UNM Electrical and Computer Engineering (ECE) is doing research to enable seamless communication between mobile and stationary devices across multiple networks and through heterogeneous communication environments. Their approach, which is funded by National Science Foundation under the FIND initiative, is based on a transient mobile network in which all communications occur between persistently identified entities. Such a network, which is mobile and ubiquitous in nature, allows entities to form and associate themselves with coordinated ad-hoc networks that are provided the means to integrate almost seamlessly with each other. Architecturally, all entities (devices, services, processes, threads) are represented as digital entities addressable via persistent identifiers. ECE’s approach leads to simplified network operations, management and provisioning, by placing all aspects of network administration into a common information management framework. This allows the overall architecture to maintain addressing and communications inter-connectivity while extensive implementation-level disruptions are carried out at the lower levels of the implementation and to adapt naturally, the incorporation of existing and future communication mechanisms and technologies.

ECE is in the early phases of designing this new type of network under the NSF Future Internet Design (FIND) initiative. The architecture has been prototyped on top of wireless mesh networks (WMN), which are particularly interesting because of their ability to operate in pure ad-hoc mode or to include some infrastructural components, making them suitable for a multitude of applications that can not be directly supported by other wireless networks such as cellular, ad hoc, and wireless sensor networks as well as standard IEEE 802.11. Broadband home networking, community and neighborhood

networking, health and medical networking, emergency and disaster networking are some examples of application where mesh networks are currently being used. ECE's prototype allows convergence of the heterogeneous mesh networks through inter-working providing a seamless service to individual network entities. Users and entities in general are securely and persistently identified on the network. Dynamic and extensible network management and service provisioning is achieved using mobile agents. These characteristics, in addition to seamless mobility, provide the user with a novel networking experience and a broader innovation space.